



Goddard Space  
Flight Center  
National Aeronautics and  
Space Administration



# Laser Repairable Chip On Board

**Code 562/661 DDF**

**Patty Friedberg**

**Stan Hunter**

**Jong Kadesch**

**Jeannette Plante**

**Harry Shaw**

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## Laser Repairable Chip On Board

- Chip-on-Board (COB) packaging technology can provide a high degree of miniaturization at relatively low cost
- There are risks and tradeoffs:
  - Lack of established design rules and tools
  - Unknown quality of die
  - Difficulty of rework

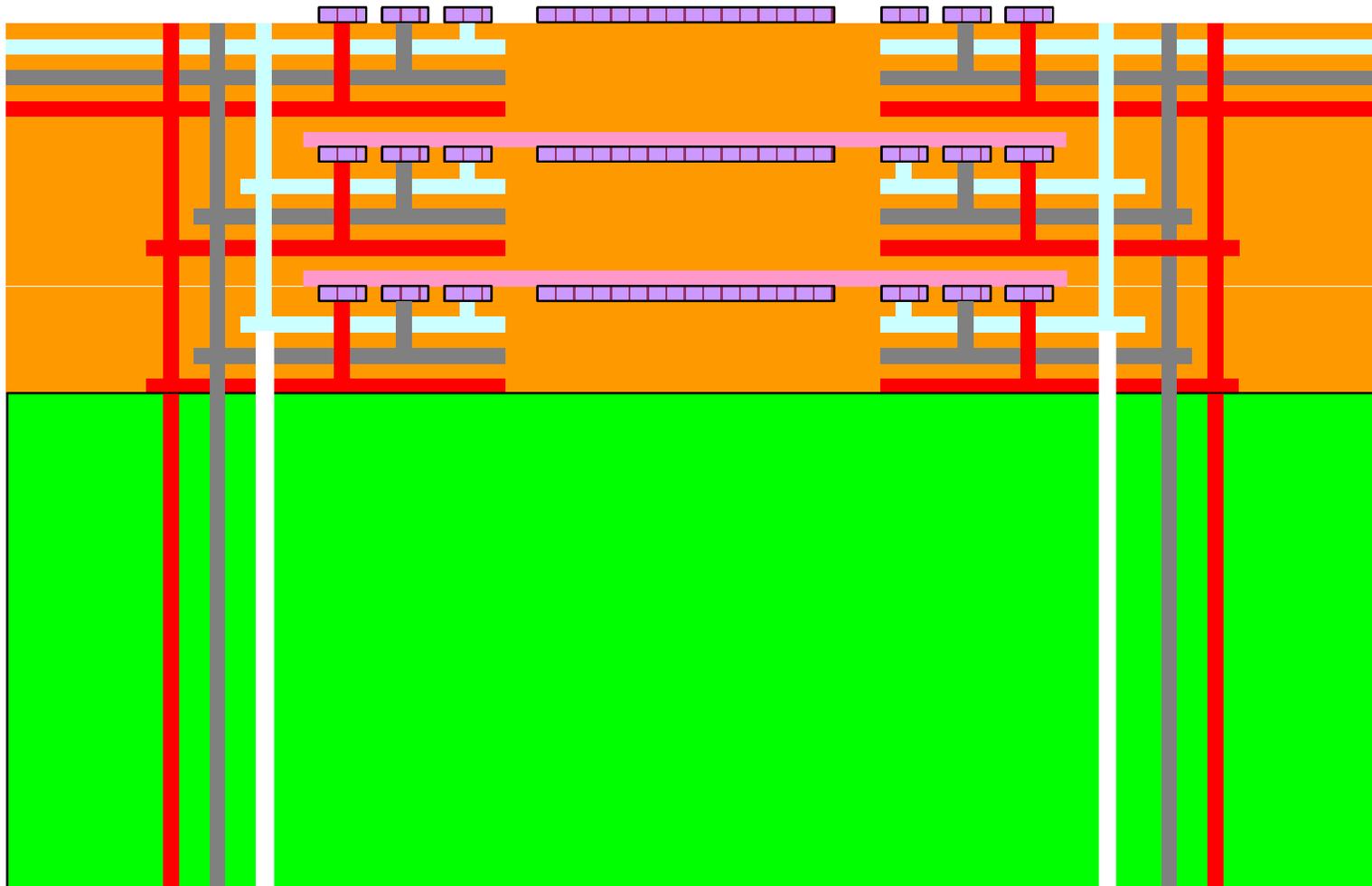
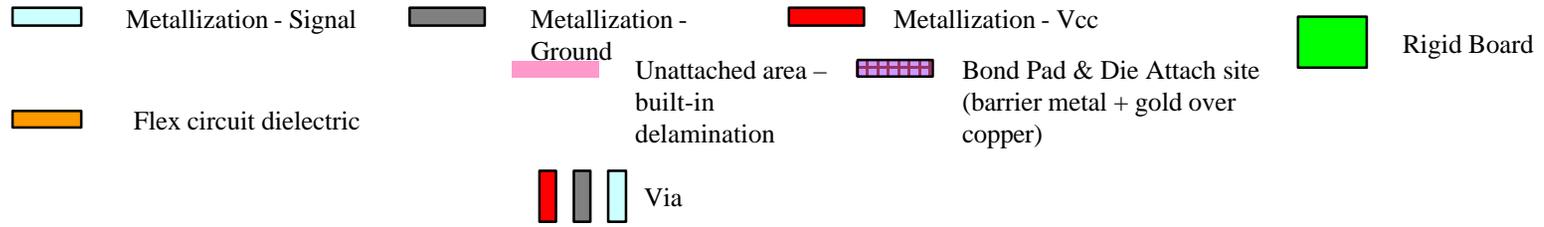
## Advantages of Laser Repairable Chip On Board

- Non-contact rework.
- Ambient temperature rework. Assemblies do not have to be heated to loosen die attach epoxy.
- Rework at very high part density.
- Higher reliability of reworked site

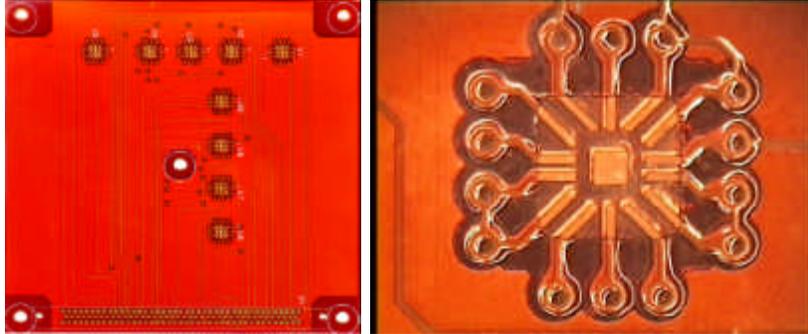
## Description of the Designs - Version 1

- Version 1:
  - Four layers of flex laminated to rigid board.
  - Four die attach layers (three repairs possible).
  - Two GND/PWR planes.
  - All layers are polyimide.
  - Vias are through hole punches.
  - No buried vias.
  - Trace spacing is min 25 mils.
  - Nine sites (NAND Gates)

COB Diagram



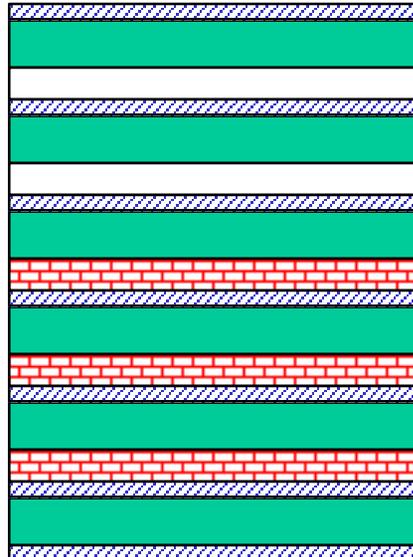
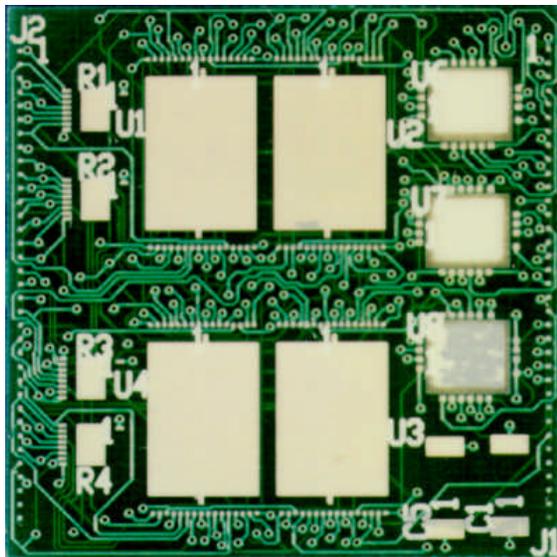
# First generation Polyimide Rigid-Flex Laser Repairable Chip-on-Board



## Description of the Designs - Version 2

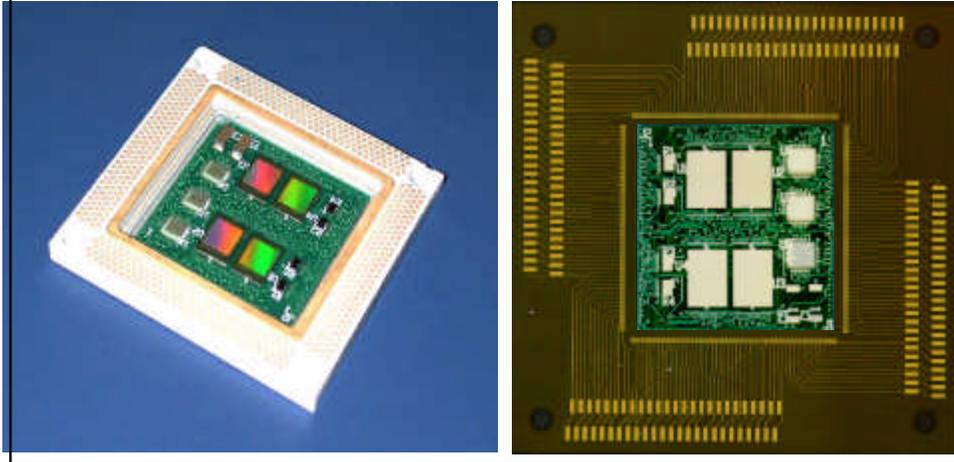
- Version 2:
  - 6 Rigid layers
  - 2 repair sites below surface
  - 2 GND/PWR planes.
  - All layers are epoxy (FR4).
  - Through hole vias
  - Trace spacing is 6 mil min
  - Three sites

# Second Generation FR4 Rigid Laser Repairable Chip-on-Board



←	Top layer H/0 GFN UV board	0.005"
←	GE no flow prepreg A11 1080	0.003"
←	Inner layer1 H/0 GFN UV board	0.005"
←	GE no flow prepreg A11 1080	0.003"
←	Inner layer2 H/0 GFN UV board	0.005"
←	GE prepreg A11 1080	0.003"
←	Inner layer3 H/0 GFN UV board	0.005"
←	GE prepreg A11 1080	0.003"
←	Inner layer4 H/0 GFN UV board	0.005"
←	GE prepreg A11 1080	0.003"
←	GND/VCC layer H/H GFN UV board	0.005"
←	1 mil adhesive/1 mil kapton LF0110	0.002"
	<b>Total</b>	<b>0.047"</b>

## Applications - High Density, 3D Multi-Chip Modules



## Future Plans

- Qualification for Space Environment
- Packaging option for in-house 600/900 instruments
- Extend to higher density packaging designs and additional applications (microwave, high power, etc.)

## Visual Inspection

- Version 1:
  - bowing: 1% to 3% (1% or less is required for good die attach)
  - good gold coverage in die attach and wire bond sites
  - some excess polyimide in die attach and wire bond site
  - ample length on wire bond “fingers”
  - registration between repairable layers between 5% and 30% off
  - electrically correct and no opens/shorts

## Visual Inspection: Version 2

- In process

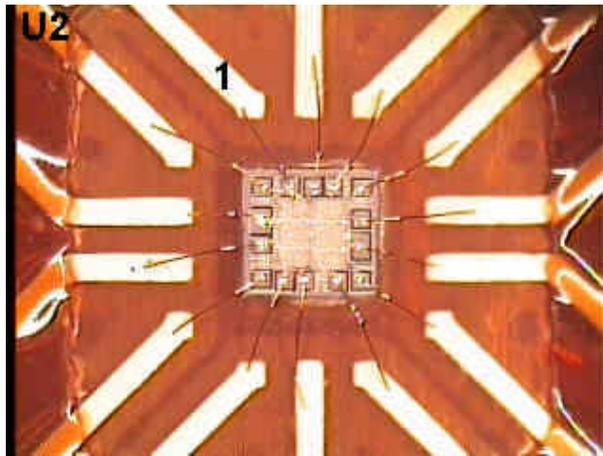
## Die Attach

- **Version 1:**
  - Cleanliness an issue. Requires plasma cleaning and care in handling and storage to maintain cleanliness.
  - Shear Strength (pass > 0.7 kg):
    - on “as-delivered” board: 1.0kg to 1.85 kg
    - on temperature, vacuum, laser processed conditioned board: TBD
- **Version 2: TBD**

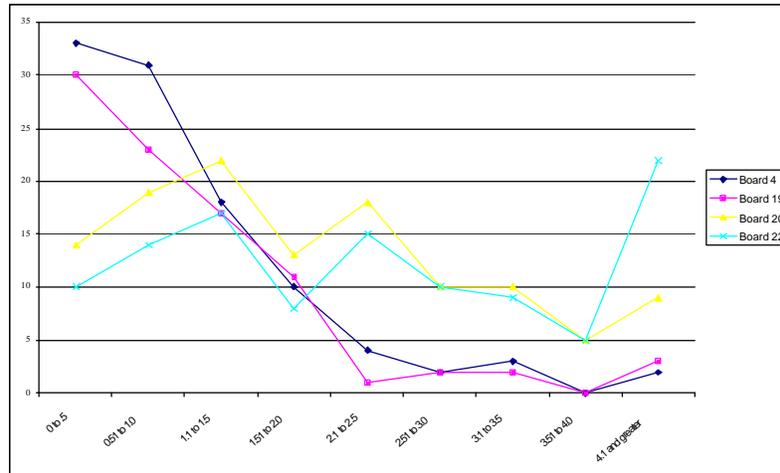
## Wire Bond

- **Version 1: (pass > 3.0 g)**

“as-delivered” boards were difficult to wirebond due to the lack of rigidness at the bond site. Heated stage exacerbated this problem. Bond pull data shows improved process with experience, though still not acceptable.



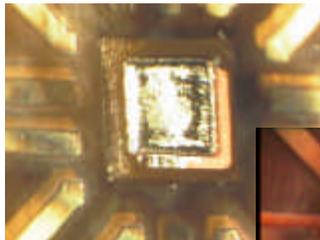
## Wire Bonds Cont.



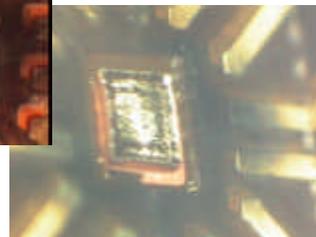
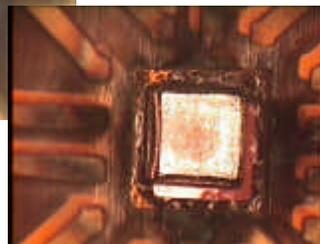
- Version 2: data not yet available

## Laser Processing

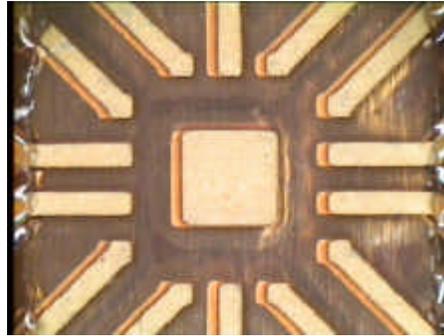
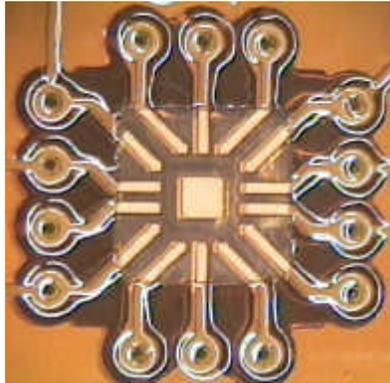
- A UV Pulsed Laser using 50, 100, 150 and 200 pulses was used to establish the process for processing one layer. Each were successful.



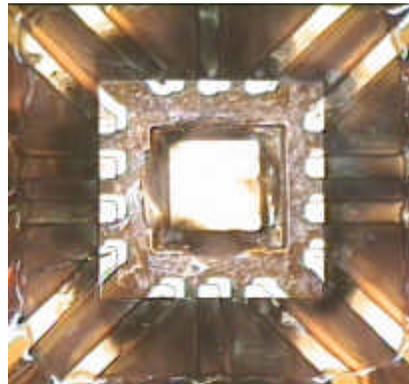
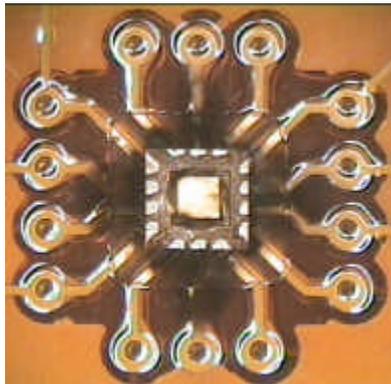
Precision cut though polyimide is blackened. Cannot cut through metal or die



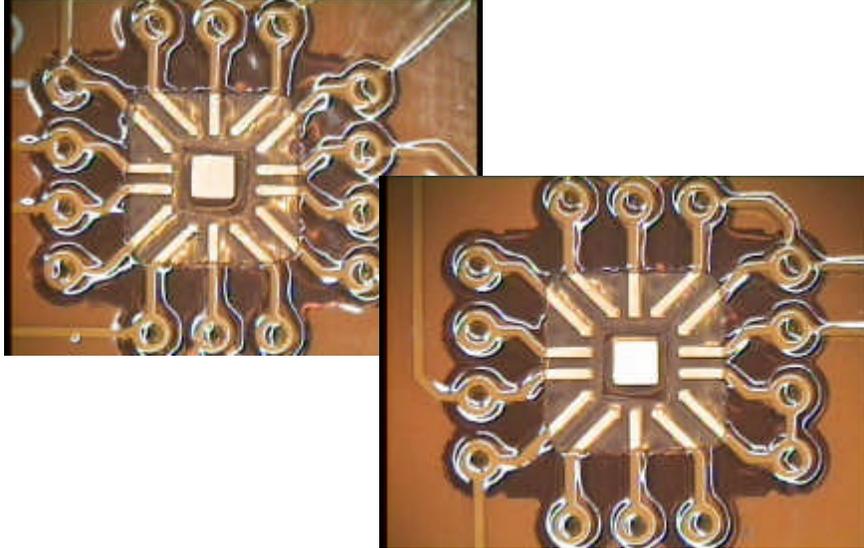
No impact on ability to Laser Machine from  
Conditioning Boards (Vacuum and Thermal Cycling)



Success with machining two and  
three layers at a time



Good Success with Laser Cutting with Die Attached



## Remaining Work and Future Opportunities

- Die Shear and Bond Pull for Version I
- Analysis of ability to make good bonds to this surface
- Analysis of conditioning on die attach and wire bond strength
- Die attach and wire pull for Version II
- Conditioning Version II
- Laser and hand rework of Version II
- Die attach and wire pull Version II